Appendix 14.1:
Air Quality Monitoring Survey (2015 and 2016)

Appendix 14.1 - Air Quality Monitoring Survey (2015 and 2016)

Introduction

14.1.1 This Appendix presents the details and results of the air quality monitoring survey carried out by Waterman to support the air quality assessment for the Development, as presented in **Chapter 14: Air Quality** for the latest full years of monitoring data (as 2015 and 2016).

14.1.2 As presented in **Annex A**, a short term air quality monitoring study for nitrogen dioxide (NO_2) was undertaken at the Brent Cross Cricklewood Regeneration Area (hereafter referred to as the 'Site'), in the administrative boundary of London Borough of Barnet (LB Barnet), by Waterman. This monitoring was undertaken from end of August 2014 to end of November 2014 to establish air quality conditions at and surrounding the Site to inform baseline conditions as presented in the FIR for Phase 1A (North) RMA. In addition, this monitoring was used within the model verification of the road emissions for the FIR for Phase 1A (North) RMA.

14.1.3 As detailed in **Chapter 14: Air Quality**, the air quality assessment does not remodel the traffic emissions associated with the Development as the changes to the road infrastructure associated with the entire scheme was considered and approved for the FIR for Phase 1A (North) RMA. The ADMS-Roads model has not been remodelled but has been re-run to take account of the locations of future sensitive exposure within the Development and to capture an increase in the amount of retail floorspace proposed for the Brent Cross Shopping Centre. In order to show the impacts of the Development the individual contribution from the emissions generated by the proposed bus station, bus station ventilation ducts and energy centre have been added to the traffic model results in order to determine the overall impacts and effects of the Development. As such the monitoring data for the period August 2014 to end November 2014 is still considered applicable and remains part of the data used within the model verification of the road emissions. The monitoring report and data (as submitted within the FIR for Phase 1A (North RMA)) for this period is presented in **Annex A** of this appendix.

14.1.4 The results obtained from this monitoring study have been used to provide information about the baseline air quality conditions around the Site and to verify the air quality modelling of the bus station, as discussed in **Chapter 14: Air Quality** and **Appendix 14.2: Air Quality Modelling Study**.

14.1.5 Between 23rd December 2014 and 19th December 2016 NO_2 diffusion tubes were placed at a total of 18 locations at ground level on and around the Site. These locations were chosen to obtain a good distribution across the Site and to capture different emission sources to assist with the air quality modelling assessment (such as NO_2 concentrations at the existing bus station at the Brent Cross Shopping Centre). In addition, tubes were co-located at the automatic monitor at Tally Ho Corner operated by the LB Barnet Council, to allow adjusting the monitoring results for bias (see full details further below).

Methodology

14.1.6 The air quality monitoring study detailed in this report is for the period 22nd December 2014 to 19th December 2016 and consisted of deploying two NO_2 diffusion tubes at each of the 18 locations as shown in **Figure 14.1**, and three tubes at the Tally Ho Corner automatic monitor (OS Grid Reference 526350, 92166), which were changed monthly throughout the monitoring period.

14.1.7 The diffusion tubes were mounted on lampposts approximately 1.8m above ground level on and around the Site.

Diffusion Tubes

14.1.8 Diffusion tube monitoring is a method for screening the air quality in an area in order to give an indication of average air pollutant concentrations. The method consists of a tube with an appropriate absorbent material at one end, mounted on to street furniture. The preparation method used is 20% TEA (triethanolamine) in water and the tubes are exposed by removing the bottom cap to allow sampling.

14.1.9 Following the relevant exposure period, the cap is replaced and the tube sent to a laboratory for analysis. For this survey, the tubes were purchased from Gradko International Ltd (a UKAS Accredited laboratory) and, following exposure, returned to the laboratory for analysis.

Diffusion Tube Co-location

14.1.10 Diffusion tubes may systematically under or over-read NO_2 concentrations when compared to an automatic analyser. To improve accuracy, it is best practice to deploy duplicate / triplicate tubes specifically co-located with an automatic monitor. This enables inter-comparison of monitored results and allows to determine the 'bias' in diffusion tube results. This bias can then be corrected to improve the accuracy of the diffusion tube results, using a suitable bias adjustment factor.

14.1.11 As part of the monitoring study, triplicate diffusion tubes were located at the Tally Ho Corner automatic monitor in order to derive a local bias adjustment factor. A locally derived bias adjustment factor is more appropriate than using a national factor (available from Defra)[1] as NO_2 concentrations at all of the diffusion sites are significantly influenced by emissions from nearby roads. In accordance with existing diffusion tube guidance[2], the bias adjustment factors should be determined from co-location studies at similar monitoring locations.

14.1.12 The local bias spreadsheet tool, developed by Defra to help local authorities calculating precision, accuracy and bias adjustment factors[3], has been used to check the accuracy of the triplicate diffusion tubes with the Tally Ho Corner automatic monitor.

14.1.13 The spreadsheet provides a Coefficient of Variation (CV) of the diffusion tube results, which represents their precision and is an indicator of the overall performance of the diffusion tubes. Tube precision is separated into two categories, 'good' or 'poor'. Tubes are considered to have 'good' precision where the coefficient of variation of duplicate or triplicate diffusion tubes for eight or more periods during the year is less than 20%, and the average CV of all monitoring periods is less than 10%. Tubes are considered to have 'poor' precision where the CV of four or more periods is greater than 20% and/or the average CV is greater than 10%.

14.1.14 A summary of the data from the co-location study is presented in **Table A14.1.1** and a copy of the precision and accuracy spreadsheet presented in **Annex B**. The average CV for the co-location in both years is less than 10%, and as such shows 'good' precision, and therefore the adjustment factor of 0.87 has been applied to the monitoring results in 2015 and 0.71 applied to the results in 2016.

1 http://laqm.defra.gov.uk/bias-adjustment-factors/national-bias.html
2 Laxen and Marner for Defra, 2006, 'The relationship between diffusion tube bias and distance from the road'
3 http://laqm.defra.gov.uk/bias-adjustment-factors/local-bias.html

Table A14.1.1: Co-location Data at Tally Ho Corner

Monitoring Year	Diffusion Tubes		Automatic Monitor	Bias Adjustment
	Period Mean	Tube Mean CV (% Precision)	Period Mean	
2015	58	4	51	0.87
2016	63	3	45	0.71

Results

14.1.15 In 2016 a review of the monitoring data was undertaken in order to improve the spatial capture of monitoring. As such the following monitoring sites were discontinued on the 6th July 2016 due to the monitoring concentrations being continually below the NO_2 Air Quality Strategy Objective or due to repeated vandalism resulting in very low data capture:

- Diffusion Tube Site 5: 5. Clitterhouse Road;
- Diffusion Tube Site 7: Brent Terrace;
- Diffusion Tube Site 13: A41 Hendon Way; and
- Diffusion Tube 8: Handley Grove.

14.1.16 From the 1st June 2016 monitoring began at the following locations:

- Diffusion Tube Site 15: Quantock Gardens/ Claremont Road; and
- Diffusion Tube Sites 16 to 18: Existing Brent Cross Bus Station.

14.1.17 The above monitoring sites short-term sampling period is sufficient to provide a reasonable assessment of existing air quality in an area but it is not an exact equivalent of the annual mean. However, if long-term (yearly) data sets are available from nearby monitoring networks, it is possible to identify a correlation between short and long-term data sets and estimate annual means from short-term data sets using the correlation.

14.1.18 Following guidance in Defra's Local Air Quality Management Technical Guidance (LAQM.TG(16))[4] (Box 7.9) estimating annual mean concentrations from short-term monitoring data entails deriving a scaling factor, from other long-term monitoring locations, to adjust the monitoring period mean.

14.1.19 Scaling factor estimation is based on the fact that patterns in pollutant concentrations usually affect a wide region and are subject to seasonal changes. To minimise the impact of the local traffic the monitoring locations used in the scaling exercise should be distanced from sources of pollution and broadly representative of city-wide urban background conditions.

14.1.20 Following the methodology in LAQM.TG(16), in order to derive a scaling factor without any significant error, data from two to four nearby long-term monitoring sites, located at urban background locations and ideally forming part of the national network are required. It is estimated that the distance between sites should not be larger than 50 miles (80km).

14.1.21 There are a number of urban background automatic monitoring stations in central London, from which the following four monitoring locations were selected:

- North Kensington – Kensington and Chelsea, approximately 5.5km from the Site;
- Stanmore – Harrow, approximately 7.7km from the Site;
- Bloomsbury – Camden, approximately 8.3km from the Site; and

[4] Defra, 2016, Local Air Quality Management Technical Guidance LAQM.TG(16)

- Sir John Cass School – City of London, approximately 11.6km from the Site.

14.1.22 The above automatic monitors form part of the London Air Quality Network (LAQN) and monitoring data is available for all monitors for the full year of 2016.

14.1.23 The ratio of the short-term monitoring Period Mean (PM) for NO_2 for the following periods at the following monitoring sites to the latest NO_2 Annual Mean (AM) concentration (for 2016) at the same site was obtained, as shown in **Table A14.1.2** and **Table A14.1.3**:

- Period 1: 22nd January 2016 to 6th July 2016 – representative of the monitoring duration at Monitoring Sites 5, 7 and 12. Monitoring Site 8 has been discounted due to insufficient monitoring data in 2016; and
- Period 2: 1st June 2016 to 19th December 2016 - representative of the monitoring duration at Monitoring Sites 15, 16, 17 and 18.

Table A14.1.2: Adjustment Process to Estimate Annual Mean NO_2 Concentrations at the Site (Period 1)

	Annual Mean 2016 [AM]	Period Mean [PM]	Ratio (AM/PM) [R]
North Kensington, Kensington and Chelsea	33.8	33.3	1.014
Stanmore, Harrow	43.4	35.9	1.210
Bloomsbury, Camden	43.0	42.9	1.001
Sir John Cass School, City of London	41.8	41.8	0.999
Average			**1.056**

Table A14.1.3: Adjustment Process to Estimate Annual Mean NO_2 Concentrations at the Site (Period 2)

	Annual Mean 2016 [AM]	Period Mean [PM]	Ratio (AM/PM) [R]
North Kensington, Kensington and Chelsea	33.8	32.6	1.039
Stanmore, Harrow	43.4	45.9	0.946
Bloomsbury, Camden	43.0	40.9	1.050
Sir John Cass School, City of London	41.8	39.9	1.048
Average			**1.021**

14.1.24 The average of the four ratios between the sampling period and annual mean NO_2 concentrations was then applied to the short-term NO_2 diffusion tube results for the diffusion tubes with each respective period.

14.1.25 Following the LAQM.TG(16) guidance, given that the calculation is carried out using the ratio of the short-term monitoring period to the 2016 annual mean, the resulting concentration is an estimation of the annual mean for the year 2016 at each monitoring site.

14.1.26 The results of the NO_2 monitoring are presented in **Table A14.1.4**, including the estimated bias adjusted annual mean, using the correction factor calculated above.

Table A14.1.4: NO_2 Monitoring Results at the Site

Location	2015		2016	
	Annual Average	Bias Adjusted Annual Average[a]	Annual Average	Bias and Annualised Adjusted Average[b]
1. Ethridge Road	**69.2**	**60.2**	**73.0**	**51.9**
2. Layfield Road	39.6	34.4	**45.5**	32.3
3. Claremont Road	**53.3**	**46.4**	**59.0**	**41.9**
4. Wallcote Avenue	33.5	29.1	37.3	26.5
5. Clitterhouse Road	**40.9**	35.6	**51.8**	38.9[c]
6. Purbeck Drive	37.0	32.2	**46.9**	33.3
7. Brent Terrace	37.5	32.6	**43.2**	32.4[c]
8. Handley Grove	37.8	32.9	Monitoring Stopped [e]	
9. Claremont Road	**71.6**	**62.3**	**77.6**	**55.1**
10. 274 Cricklewood Lane	**82.6**	**71.8**	**87.6**	**62.2**
11. The Vale	**65.7**	**57.1**	**76.7**	**54.4**
12. Brentfield Gardens	**75.3**	**65.5**	**81.7**	**58.0**
13. A41 Hendon Way	**80.3**	**69.9**	**90.4**	**67.8[c]**
14. Edgware Road	**48.1**	**41.9**	**57.9**	**41.1**
15. Quantock Gardens/ Claremont Road	No Data[d]		**57.8**	**42.0[d]**
16. Bus Station 1	No Data[d]		**73.9**	**53.6[d]**
17. Bus Station 2	No Data[d]		**76.8**	**55.7[d]**
18. Bus Station 3	No Data [d]		**77.3**	**56.0[d]**

Notes
[a] Multiply previous column by 0.87
[b] Multiply previous column by 0.71
[c] Monitoring stopped on 6th July 2016. Data has been annualised by 1.056
[d] Monitoring started on 1st June 2016. Data has been annualised by 1.021
[e] Monitoring stopped due to monitoring continually stolen or vandalised throughout 2016
In bold, exceedence of the NO_2 AQS objective of 40µg/m^3

14.1.27 Overall, based on the survey, estimated annual averages exceed the NO_2 annual mean objective at the majority of the locations (8 out of 14 in 2015 and 12 out of 17 in 2016). These latest results are consistent with those presented in the s.73 application and EIA Documentation (which showed 9 out of 14 sites exceeding the NO_2 annual mean objective in 2014). The highest concentration in 2015 is measured at the diffusion tube located on Cricklewood Lane (as 71.8µg/m^3) and in 2016 is measured at the diffusion tube located on the A41 Hendon Way (as 67.8µg/m^3).

Annexes

Annex A – Air Quality Monitoring Survey for 2014 (as approved for the FIR for Phase 1A (North) RMA

Appendix 14.1 - Air Quality Monitoring Survey

Introduction

14.1.1 This Appendix presents the details and results of the air quality monitoring survey carried out by Waterman to support the air quality assessment for the Development, as presented in Chapter 14: Air Quality.

14.1.2 A short term air quality monitoring study for nitrogen dioxide (NO_2) was undertaken at the Brent Cross Cricklewood Regeneration Area (hereafter referred to as the 'Site'), in the administrative boundary of London Borough of Barnet (LB Barnet), by Waterman. The monitoring study was undertaken from August 2014 to October 2014 to establish current air quality conditions at and surrounding the Site.

14.1.3 The Site, which occupies 151 hectares (ha) of land includes the existing Brent Cross Shopping Centre to the north, the A41 and Brent Cross London Underground Station to the east, Cricklewood Lane to the south, the A5 to the west and the M1 to the northwest. The location of the Site is shown in **Figure 14.1**.

14.1.4 The results obtained from this monitoring study have been used to provide information about the baseline air quality conditions around the Site, and to verify the air quality model (comparison of monitored and modelled concentrations) used to predict future air pollutant concentrations at the Site, as discussed in **Chapter 14: Air Quality**.

14.1.5 NO_2 diffusion tubes were placed at fourteen locations at ground level on and around the Site. These locations were chosen to obtain a good distribution across the Site. In addition, tubes were co-located at the automatic monitor at Tally Ho Corner operated by the LB Barnet Council, to allow adjusting the monitoring results for bias (see overleaf for further details).

Methodology

14.1.6 The air quality monitoring study was undertaken for a two-month period from 22nd August 2014 to 22nd October 2014 and consisted of deploying two NO_2 diffusion tubes at each of the fourteen locations as shown in **Figure 14.1**, and three tubes at the Tally Ho Corner automatic monitor (OS Grid Reference 526350, 92166), which were changed monthly throughout the monitoring period.

14.1.7 This time period is sufficient to provide a reasonable assessment of existing air quality in an area, but it does not provide data equivalent to the annual mean. The annual mean was therefore estimated from the short-term monitoring results.

14.1.8 The diffusion tubes were mounted on lampposts approximately 1.8m above ground level on and around the Site.

Diffusion Tubes

14.1.9 Diffusion tube monitoring is a method for screening the air quality in an area in order to give an indication of average air pollutant concentrations. The method consists of a tube with an appropriate absorbent material at one end, mounted on to street furniture. The preparation method used is 20% TEA (triethanolamine) in water and the tubes are exposed by removing the bottom cap to allow sampling.

14.1.10 Following the relevant exposure period, the cap is replaced and the tube sent to a laboratory for analysis. For this survey, the tubes were purchased from Gradko International Ltd (a UKAS Accredited laboratory) and, following exposure, returned to the laboratory for analysis.

Diffusion Tube Co-location

14.1.11 Diffusion tubes may systematically under or over-read NO_2 concentrations when compared to an automatic analyser. To improve accuracy, it is best practice to deploy duplicate / triplicate tubes specifically co-located with an automatic monitor. This enables inter-comparison of monitored results and allows to determine the 'bias' in diffusion tube results. This bias can then be corrected to improve the accuracy of the diffusion tube results, using a suitable bias adjustment factor.

14.1.12 As part of the monitoring study, triplicate diffusion tubes were located at the Tally Ho Corner automatic monitor in order to derive a local bias adjustment factor. A locally derived bias adjustment factor is more appropriate than using a national factor (available from Defra)[1] for the following reasons:

- The survey has not been carried out over a calendar year (the national factors have been determined on a calendar year basis); and
- NO_2 concentrations at all of the diffusion sites are significantly influenced by emissions from nearby roads. In accordance with existing diffusion tube guidance[2], the bias adjustment factors should be determined from co-location studies at similar monitoring locations.

14.1.13 The local bias spreadsheet tool, developed by Defra to help local authorities calculating precision, accuracy and bias adjustment factors[3], has been used to check the accuracy of the triplicate diffusion tubes with the Tally Ho Corner automatic monitor.

14.1.14 The spreadsheet provides a Coefficient of Variation (CV) of the diffusion tube results, which represents their precision and is an indicator of the overall performance of the diffusion tubes. Tube precision is separated into two categories, 'good' or 'poor'. Tubes are considered to have 'good' precision where the coefficient of variation of duplicate or triplicate diffusion tubes for eight or more periods during the year is less than 20%, and the average CV of all monitoring periods is less than 10%. Tubes are considered to have 'poor' precision where the CV of four or more periods is greater than 20% and/or the average CV is greater than 10%.

14.1.15 A summary of the data from the co-location study is presented in **Table A14.1** and a copy of the precision and accuracy spreadsheet presented in Annex A. The average CV for the co-location is less than 10%, and as such shows 'good' precision, and therefore the adjustment factor of 0.84 been applied to the monitoring results.

Table A14.1: Co-location Data at Tally Ho Corner

Site	Diffusion Tubes		Automatic Monitor	Bias Adjustment
	Period Mean	Tube Mean CV (% Precision)	Period Mean	
Tally Ho Corner	70	3	59	0.84

Results

14.1.16 As noted previously, the short-term sampling period is sufficient to provide a reasonable assessment of existing air quality in an area but it is not an exact equivalent of the annual mean. However, if long-term (yearly) data sets are available from nearby monitoring networks, it is possible to identify a correlation

1 http://laqm.defra.gov.uk/bias-adjustment-factors/national-bias.html
2 Laxen and Marner for Defra, 2006, 'The relationship between diffusion tube bias and distance from the road'
3 www.airquality.co.uk/archive/laqm/tools.php

between short and long-term data sets and estimate annual means from short-term data sets using the correlation.

14.1.17 Following guidance in Defra's Local Air Quality Management Technical Guidance (LAQM.TG(09))[4] (Box 3.2) estimating annual mean concentrations from short-term monitoring data entails deriving a scaling factor, from other long-term monitoring locations, to adjust the monitoring period mean.

14.1.18 Scaling factor estimation is based on the fact that patterns in pollutant concentrations usually affect a wide region and are subject to seasonal changes. To minimise the impact of the local traffic the monitoring locations used in the scaling exercise should be distanced from sources of pollution and broadly representative of city-wide urban background conditions.

14.1.19 Following the methodology in LAQM.TG(09), in order to derive a scaling factor without any significant error, data from two to four nearby long-term monitoring sites, located at urban background locations and ideally forming part of the national network are required. It is estimated that the distance between sites should not be larger than 50 miles (80km).

14.1.20 There are a number of urban background automatic monitoring stations in central London, from which the following four monitoring locations were selected:

- North Kensington – Kensington and Chelsea, approximately 5.5km from the Site;
- Stanmore – Harrow, approximately 7.7km from the Site;
- Bloomsbury – Camden, approximately 8.3km from the Site; and
- Sir John Cass School – City of London, approximately 11.6km from the Site.

14.1.21 The above automatic monitors form part of the London Air Quality Network (LAQN) and monitoring data is available for all monitors for the full year of 2012. This year has been considered, rather than 2012, to be consistent with the traffic data used in as part of the air quality assessment.

14.1.22 The ratio of the short-term monitoring period mean for NO_2 (22nd August 2014 to 22nd October 2014) at the four sites to the latest NO_2 annual mean concentration (available for 2012) at the same site was obtained, as shown in **Table A14.2**.

Table A14.2: Adjustment Process to Estimate Annual Mean NO_2 Concentrations at the Site

	Annual Mean 2012 [AM]	Period Mean [PM]	Ratio (AM/PM) [R]
North Kensington, Kensington and Chelsea	36.6	34.3	1.067
Stanmore, Harrow	24.8	24.5	1.011
Bloomsbury, Camden	55.3	45.6	1.214
Sir John Cass School, City of London	46.9	40.4	1.159
Average			**1.113**

14.1.23 The average of the four ratios between the sampling period and annual mean NO_2 concentrations was then applied to the short-term NO_2 diffusion tube results. Following the LAQM.TG(09) guidance, given that the calculation is carried out using the ratio of the short-term monitoring period to the 2012 annual mean, the resulting concentration is an estimation of the annual mean for the year 2012 at each monitoring site.

[4] Defra, 2009, Local Air Quality Management Technical Guidance LAQM.TG(09)

14.1.24 The results of the NO_2 monitoring are presented in **Table A14.3**, including the estimated bias adjusted annual mean, using the correction factor calculated above.

14.1.25 As these results show, estimated annual mean NO_2 concentrations exceed the NO_2 objective of 40µg/m^3 at 11 of the 14 monitoring locations. The highest concentration is measured at the diffusion tube located on Cricklewood Lane (90.5µg/m^3).

Table A14.3: NO_2 Monitoring Results at the Site

Location	22nd August 2014 – 22nd September 2014	22nd September 2014 – 22nd October 2014	Overall Average	Adjusted/Co-location Annual Mean*	Adjusted Estimated 2012 Annual Mean**
1. Ethridge Road	75.0	88.4	83.9	70.5	**78.4**
	74.5	97.7			
2. Layfield Road	41.9	54.7	45.6	38.3	**42.6**
	38.3	47.5			
3. Claremont Road	57.4	65.9	62.0	52.1	**57.9**
	-	62.7			
4. Wallcote Avenue	32.2	43.3	37.8	31.7	35.3
	33.6	42.1			
5. Clitterhouse Road	50.2	56.2	52.9	44.5	**49.5**
	48.0	57.3			
6. Purbeck Drive	-	36.1	40.5	34.0	37.9
	-	45.0			
7. Brent Terrace	32.4	46.7	40.8	34.2	38.1
	32.3	51.6			
8. Handley Grove	39.6	-	43.1	36.2	**40.3**
	37.5	52.2			
9. Claremont Road	79.3	86.9	81.2	68.2	**76.0**
	75.4	83.4			
10. 274 Cricklewood Lane	103.7	89.0	96.8	81.3	**90.5**
	105.2	89.4			
11. The Vale	-	77.4	77.9	65.4	**72.8**
	-	78.4			
12. Brentfield Gardens	72.6	-	76.5	64.2	**71.5**
	-	80.4			
13. A41 Hendon Way	65.5	-	78.3	65.8	**73.2**
	64.1	105.5			
14. Edgware Road	75.2	50.3	64.9	54.5	**60.6**
	77.4	56.6			

* Multiply previous column by 0.84

** Multiply previous column by 1.11

In bold, exceedence of the NO_2 annual mean objective of 40µg/m^3

Annexes

Annex A – Colocated Diffusion Tubes - Precision and Accuracy Spreadsheet

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements										Automatic Method		Data Quality Check	
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
1	22/08/2014	22/09/2014	57.3	61.8	60.5	60	2.3	4	5.7	57.22	100	Good	Good
2	22/09/2014	22/10/2014	79.6	81.4	78.1	80	1.6	2	4.1	60.52	100	Good	Good
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
								Overall survey -->				Good precision	Good Overall DC

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

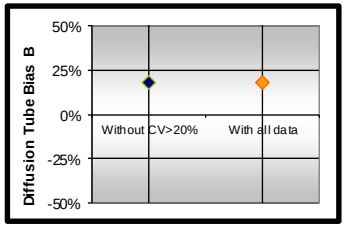
(Check average CV & DC from Accuracy calculations)

Site Name/ ID:	

Precision	2 out of 2 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval) without periods with CV larger than 20%	
Bias calculated using 2 periods of data	
Bias factor A	0.84 (0.35 - -1.9)
Bias B	19% (-153% - 190%)
Diffusion Tubes Mean:	70 μgm^{-3}
Mean CV (Precision):	3
Automatic Mean:	59 μgm^{-3}
Data Capture for periods used:	100%
Adjusted Tubes Mean:	59 (24 - -133) μgm^{-3}

Accuracy (with 95% confidence interval) WITH ALL DATA	
Bias calculated using 2 periods of data	
Bias factor A	0.84 (0.35 - -1.9)
Bias B	19% (-153% - 190%)
Diffusion Tubes Mean:	70 μgm^{-3}
Mean CV (Precision):	3
Automatic Mean:	59 μgm^{-3}
Data Capture for periods used:	100%
Adjusted Tubes Mean:	59 (24 - -133) μgm^{-3}



Jaume Targa, for AEA
Version 04 - February 2011

If you have any enquiries about this spreadsheet please contact the LAQM Helpdesk at: LAQMHelpdesk@uk.bureauveritas.com

Annex B – Co-located Diffusion Tubes - Precision and Accuracy Spreadsheet

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements									
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 µgm $^{-3}$	Tube 2 µgm $^{-3}$	Tube 3 µgm $^{-3}$	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean
1			36.8	37.1	34.1	36	1.7	5	4.1
2									
3									
4			59.2	56.2	59.0	58	1.7	3	4.2
5			51.4	53.2	50.4	52	1.4	3	3.5
6			64.1	66.3	65.1	65	1.1	2	2.7
7			67.1	66.5	62.2	65	2.6	4	6.6
8			49.7	48.0	48.8	49	0.8	2	2.1
9			46.3	47.0	46.3	47	0.4	1	1.1
10			56.9	66.7	64.5	63	5.1	8	12.8
11			68.9	71.0	64.0	68	3.6	5	8.9
12			75.9	71.1	70.9	73	2.8	4	7.0
13									

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Automatic Method	
Period Mean	Data Capture (% DC)
58.51725	99.75124378
51.17586	99.10846954
48.36259	90.06711409
0	0
54	5.630354957
48	99.70282318
44	73.92900857
43	39.19463087
48	99.85141159
51	99.34980494
45.72963	99.85652798
52.94862	96.3165075
Overall survey -->	

Data Quality Check	
Tubes Precision Check	Automatic Monitor Data
Good	Good
	Good
	Good
Good	Poor Data Capture
Good	Poor Data Capture
Good	Good
Good	Poor Data Capture
Good	Poor Data Capture
Good	Good
Good	Good
Good	Good
Good	Good
Good precision	Poor Overall DC

(Check average CV & DC from Accuracy calculations)

Site Name/ ID:

Precision 10 out of 10 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval)
without periods with CV larger than 20%

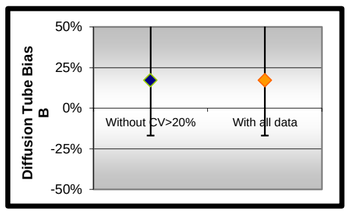
Bias calculated using 6 periods of data

Bias factor A	0.87 (0.67 - 1.23)
Bias B	15% (-19% - 49%)
Diffusion Tubes Mean:	58 µgm^{-3}
Mean CV (**Precision**):	4
Automatic Mean:	51 µgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	51 (39 - 72) µgm^{-3}

Accuracy (with 95% confidence interval)
WITH ALL DATA

Bias calculated using 6 periods of data

Bias factor A	0.87 (0.67 - 1.23)
Bias B	15% (-19% - 49%)
Diffusion Tubes Mean:	58 µgm^{-3}
Mean CV (**Precision**):	4
Automatic Mean:	51 µgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	51 (39 - 72) µgm^{-3}



Jaume Targa, for AEA
Version 04 - February 2011

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements									
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 µgm $^{-3}$	Tube 2 µgm $^{-3}$	Tube 3 µgm $^{-3}$	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean
1			75.9	71.1	70.9	73	2.8	4	7.0
2			50.1	59.9	51.0	54	5.4	10	13.5
3			62.8	57.2	62.2	61	3.1	5	7.6
4			60.4	62.1	59.2	61	1.5	2	3.7
5			59.2	61.3	62.2	61	1.6	3	3.9
6			57.0	59.3	57.1	58	1.3	2	3.3
7			51.1	52.3	50.4	51	1.0	2	2.4
8			48.8	50.8	47.6	49	1.6	3	4.0
9			65.5	65.1	65.4	65	0.2	0	0.5
10			75.4	75.5	76.6	76	0.7	1	1.8
11			70.4	74.1	72.9	72	1.9	3	4.7
12			70.4	77.1	68.8	72	4.4	6	11.0
13									

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Automatic Method	
Period Mean	Data Capture (% DC)
52.16106	96.17486339
46.68251	85.55691554
43.3281	99.75520196
40.22012	100
32	99.63811821
32	99.88109394
31	99.63280294
40	100
45	99.73992198
44	95.11599512
58.01893	100
71.05774	98.91891892

Data Quality Check	
Tubes Precision Check	Automatic Monitor Data
Good	Good
Good	Good
Good	Good
Good	Good
Good	Good
Good	Good
Good	Good
Good	Good
Good	Good
Good	Good
Good	Good
Good	Good

Overall survey -->

Good precision	Good Overall DC

(Check average CV & DC from Accuracy calculations)

Site Name/ ID:

Precision 12 out of 12 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval)
without periods with CV larger than 20%

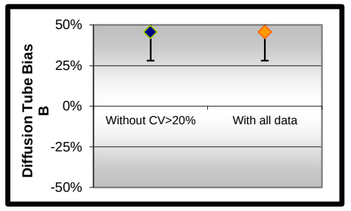
Bias calculated using 12 periods of data

Bias factor A	0.71 (0.63 - 0.81)
Bias B	40% (23% - 58%)
Diffusion Tubes Mean:	63 µgm^{-3}
Mean CV (**Precision**):	3
Automatic Mean:	45 µgm^{-3}
Data Capture for periods used:	98%
Adjusted Tubes Mean:	45 (39 - 51) µgm^{-3}

Accuracy (with 95% confidence interval)
WITH ALL DATA

Bias calculated using 12 periods of data

Bias factor A	0.71 (0.63 - 0.81)
Bias B	40% (23% - 58%)
Diffusion Tubes Mean:	63 µgm^{-3}
Mean CV (**Precision**):	3
Automatic Mean:	45 µgm^{-3}
Data Capture for periods used:	98%
Adjusted Tubes Mean:	45 (39 - 51) µgm^{-3}



Jaume Targa, for AEA
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